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# VHF/UHF Imagery of Targets, Decoys, and Trees

*A. J. Gatesman, C. Beaudoin, R. Giles, J. Waldman*  
*Submillimeter-Wave Technology Laboratory*  
*University of Massachusetts Lowell*

*J.L. Poirier, K.-H. Ding, P. Franchi, E.J. Tichovolsky, and B. Weijers*  
*Air Force Research Laboratory*  
*Hanscom Air Force Base, MA 01730*

*W. Nixon*  
*U.S. Army National Ground Intelligence Center*  
*Charlottesville, VA 22902*



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# Physical Scale Modeling Radar Measurements

- The entire VHF/UHF band can be modeled with a 2-18 GHz radar system and carefully constructed scale models and scenes

VHF: **25 MHz - 100 MHz** (using 2-8 GHz and 1/87th scale models)

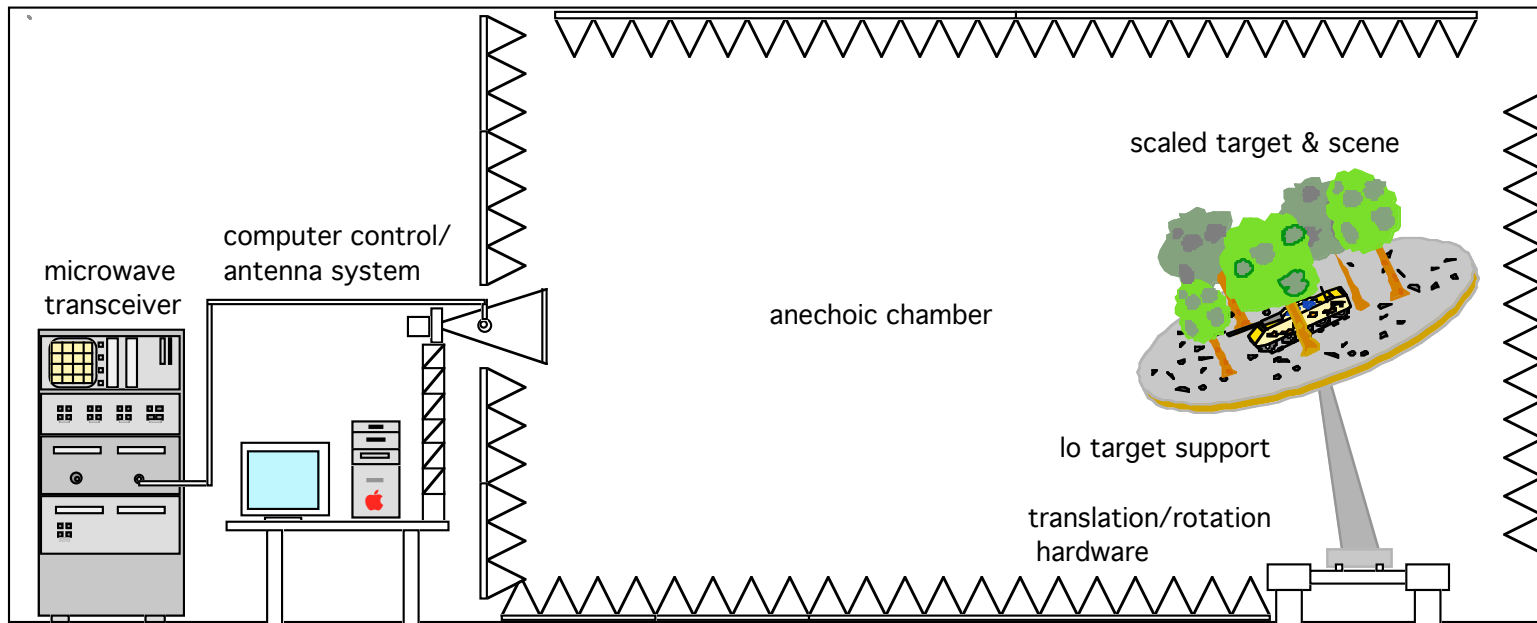
VHF/UHF: **100 MHz - 500 MHz** (using: 3.5-17.5 GHz and 1/35th scale models)

UHF: **300 MHz - 1000 MHz** (using: 4.8-16 GHz and 1/16th scale models)

## Advantages of Scale Modeling Radar Measurements:

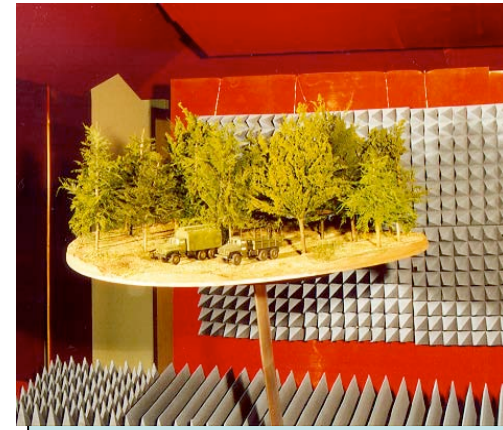
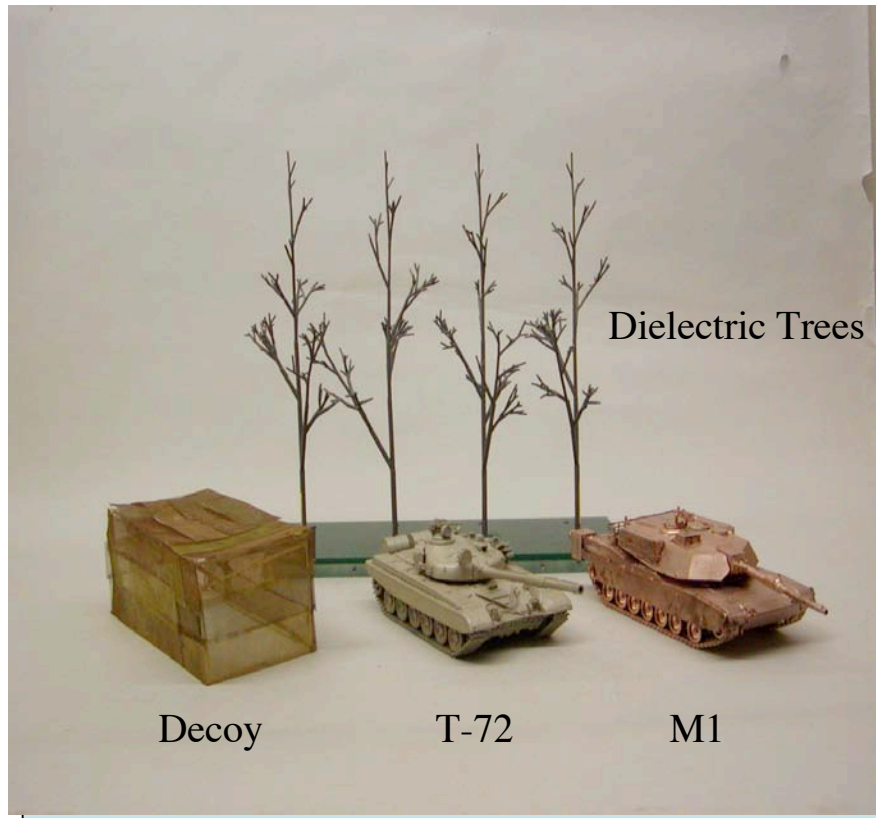
- Rapidly generate calibrated signature libraries
- Controlled, covert environment
- Models built from intelligence data
- Rough ground planes, clutter, trees

# Fully-Polarimetric Radar Range



- **2 GHz - 18 GHz Pulsed-cw Radar System**
- **Accurate Positioning of Target, Scene, and Calibration Objects**
- **Pulsing Unit Controls Polarization for Fully-Polarimetric Operation**

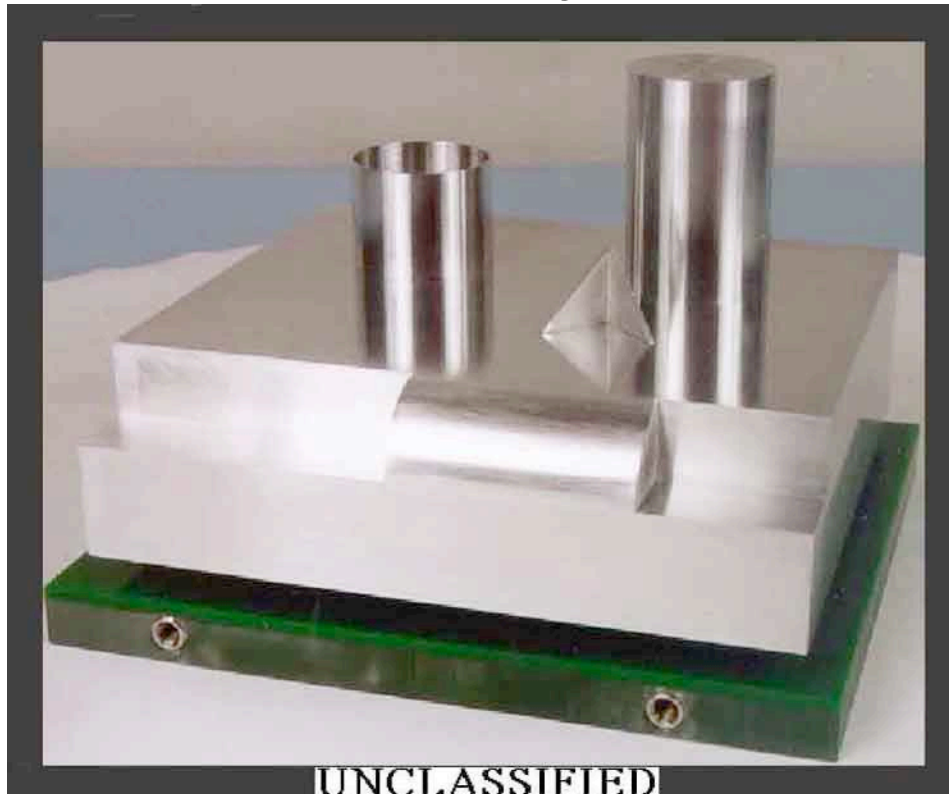
# 1/35<sup>th</sup> Scale Vehicles, Terrain and Trees





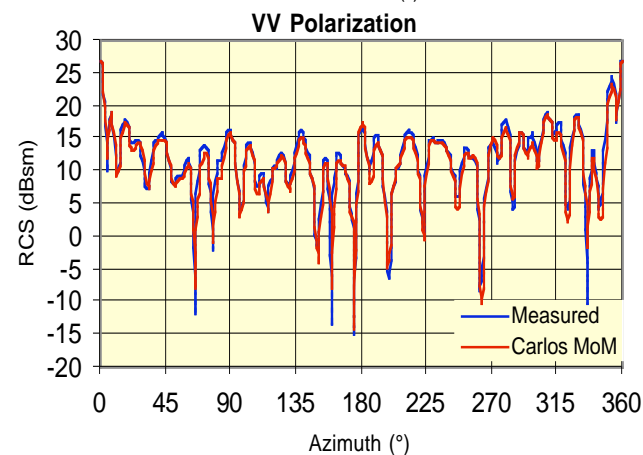
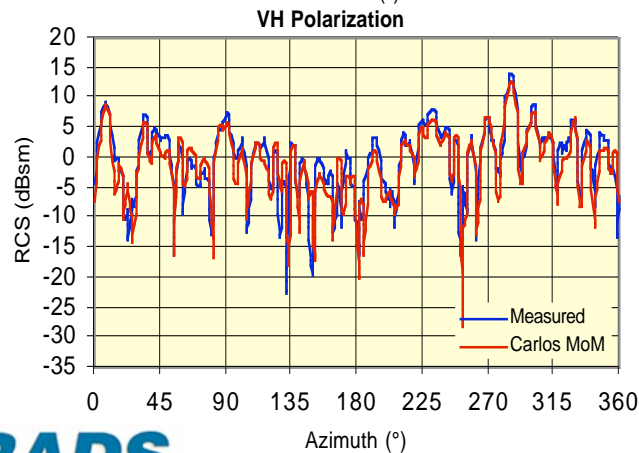
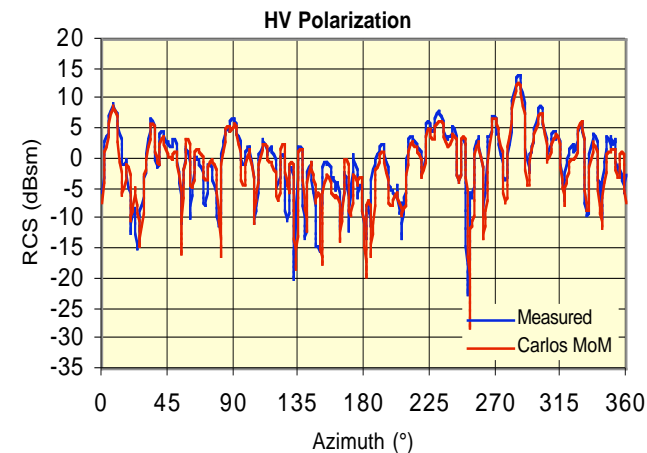
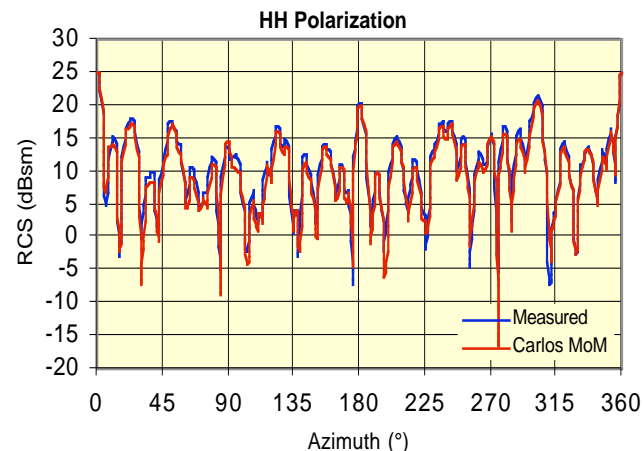
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# Signature Validation with 1/16<sup>th</sup> Scale Slicy



# VHF RCS of Slicy Compared with CARLOS

285.7 MHz and 15° elevation

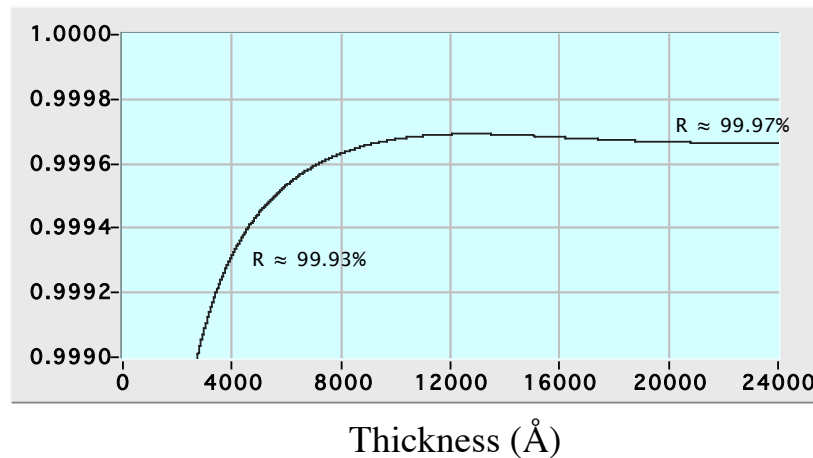




# Materials Issues

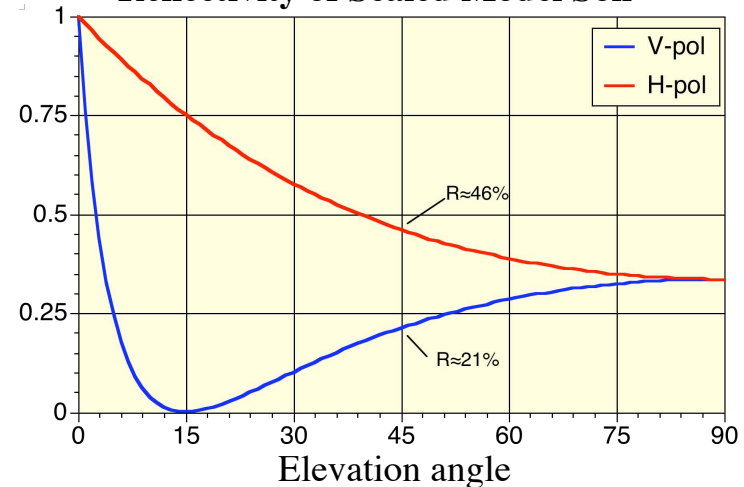
- VHF/UHF dielectric constant of wood ranges from  $\epsilon = 13 + i 3$  to  $68 + i 20$   
Scale model wood (aluminum-loaded epoxy):  $\epsilon = 69 + i 10$
- VHF/UHF dielectric constant of soil ranges from  $\epsilon = 3 + i 0.5$  to  $24 + i 5$   
Scale model soil (carbon-loaded polyurethane):  $\epsilon = 14.7 + i 1.1$

Reflectivity of 1/35th Scale M-1 Coating



- 4000 Å sputtered Cu coating on M-1 model
- Skin depth of Cu film at 10 GHz = 8000 Å

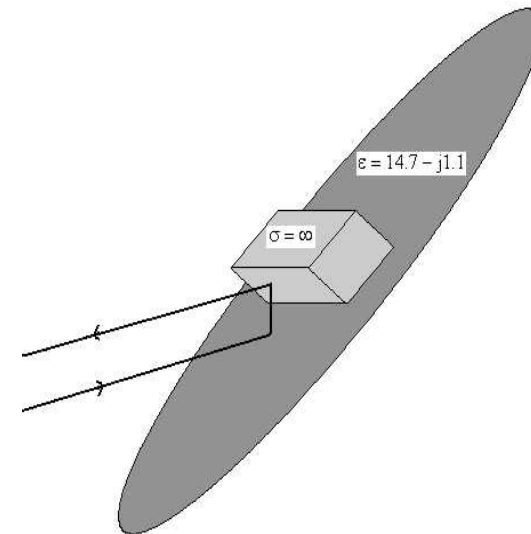
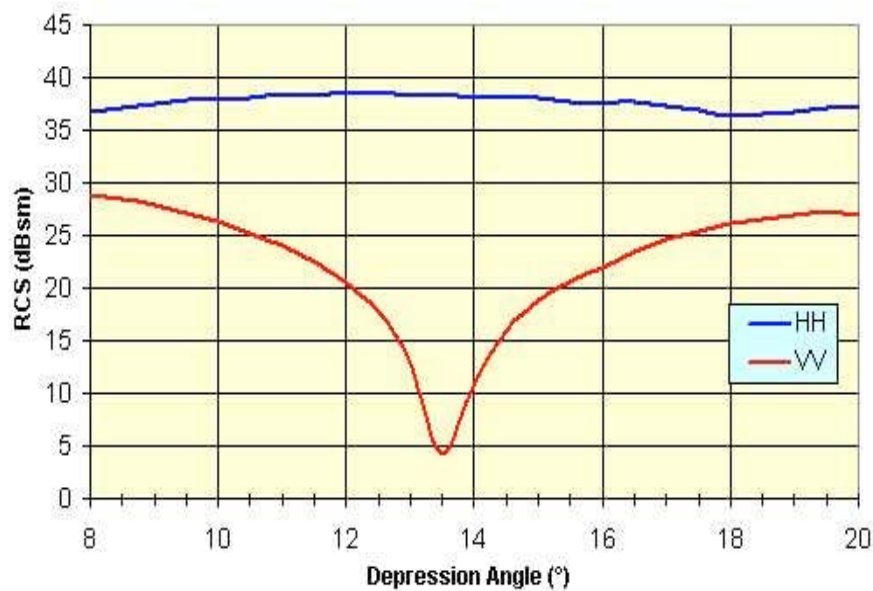
Reflectivity of Scaled Model Soil



- Brewster angle of soil = 15° elev.



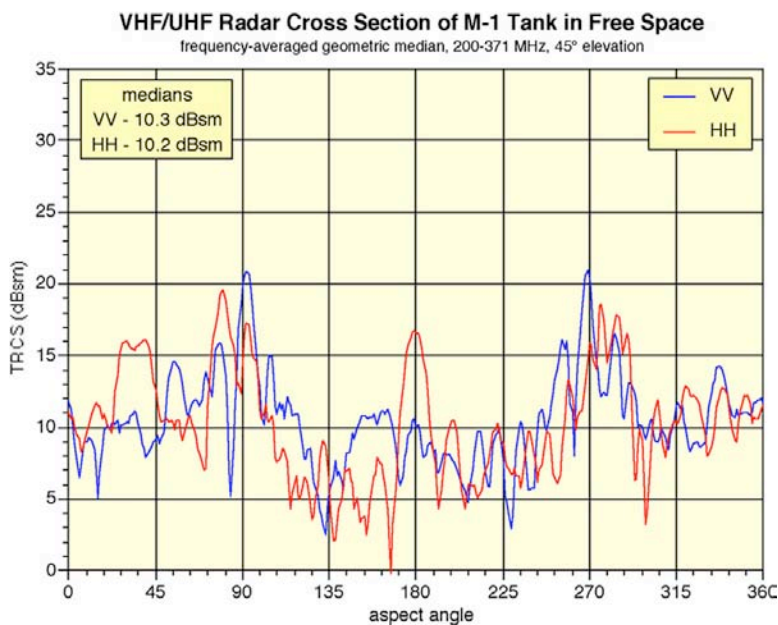
# Demonstration of Brewster's Angle at 286 MHz



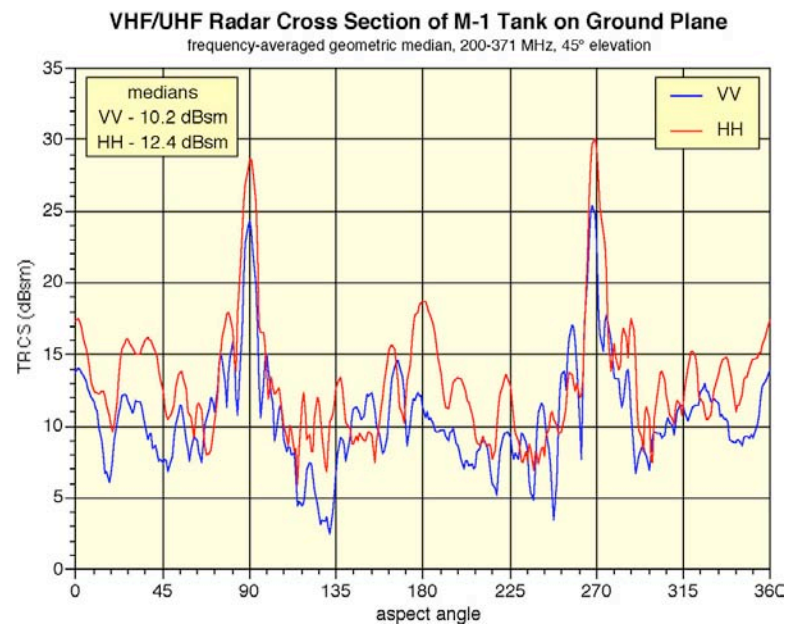
- Dihedral formed between aluminum block and ground plane to demonstrate Brewster's angle
- Ground plane dielectric constant:  $14.7 - j1.1$
- Ground plane models soil with moderate moisture content

# VHF/UHF TRCS of M-1 Tank

## Free-space

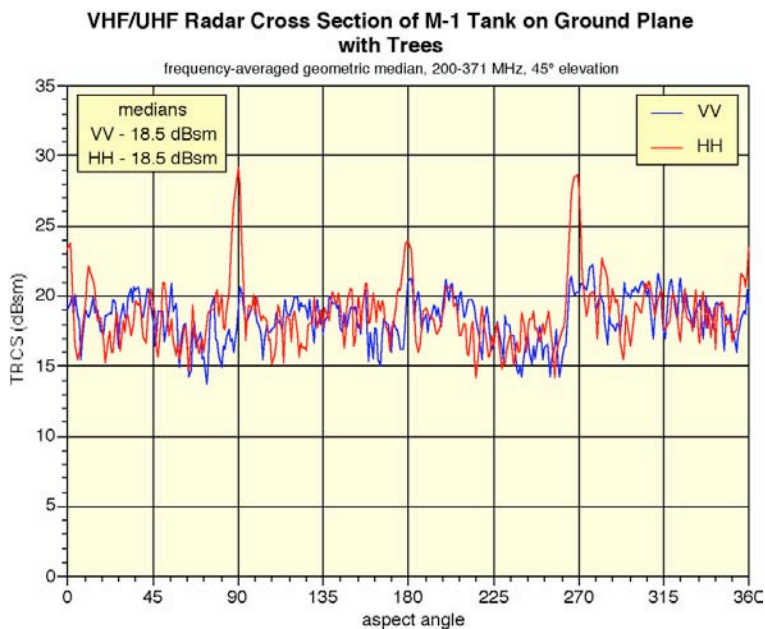


## On smooth ground plane

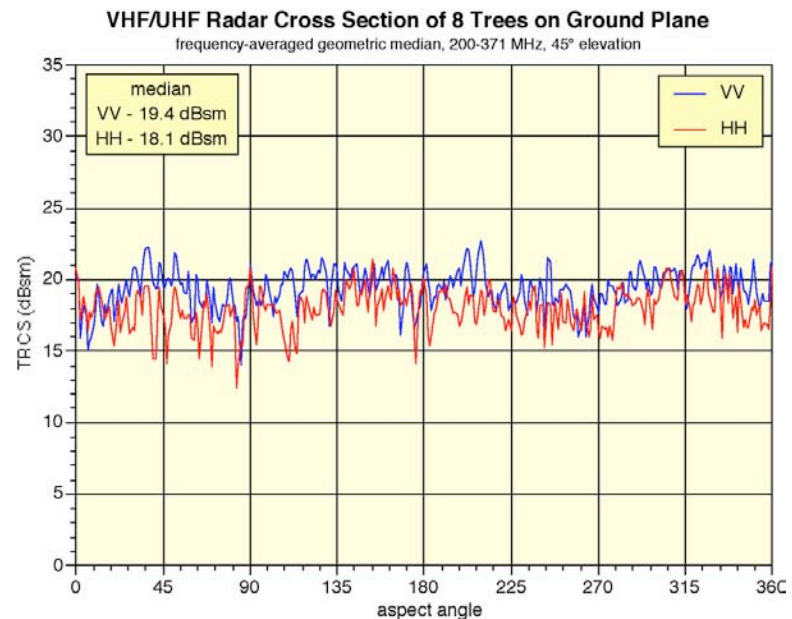


# VHF/UHF TRCS of M-1 Tank

## On ground plane with trees

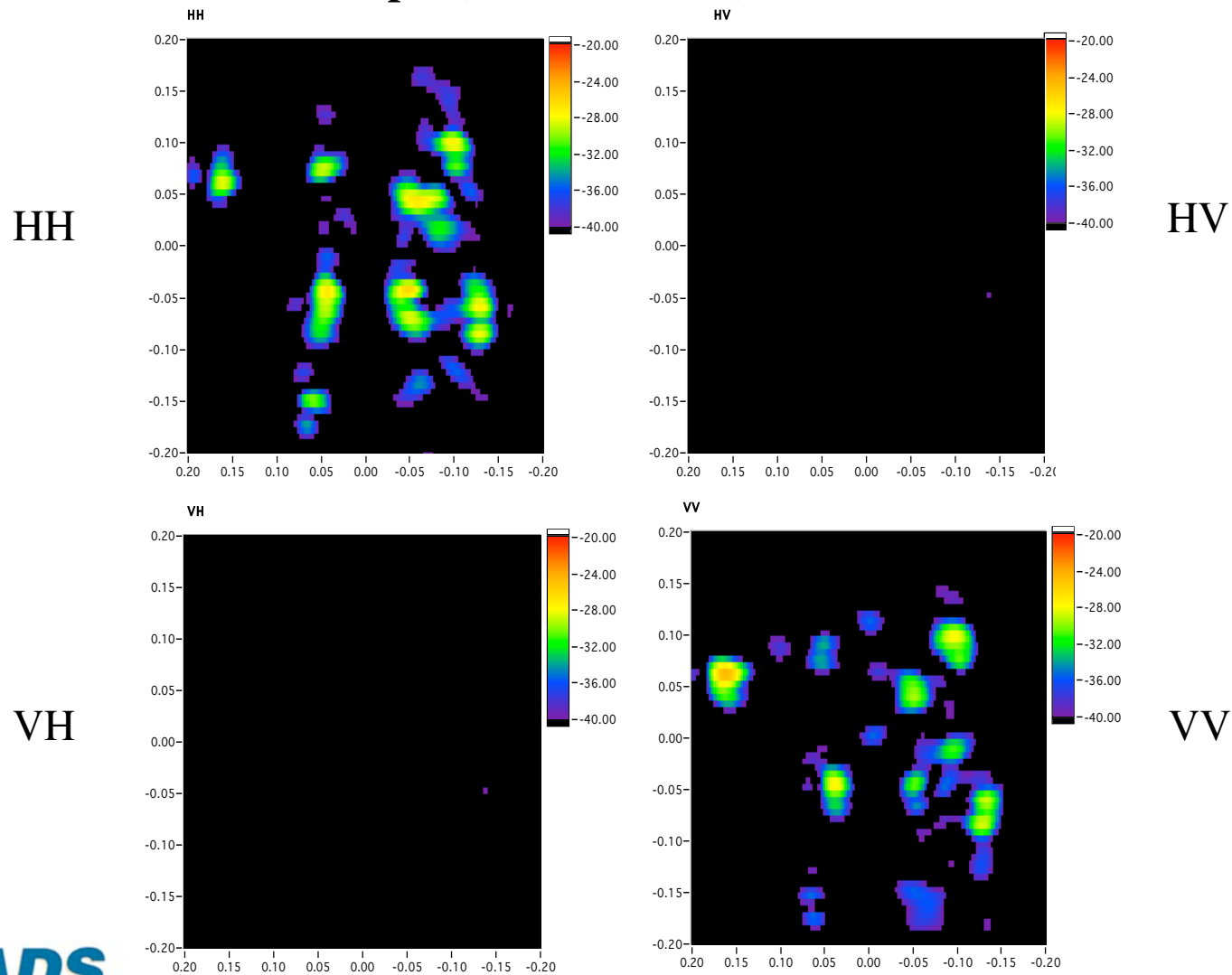


## Trees only



# Imagery of 8 Trees on Smooth Ground Plane

0° aspect, 45 ° elevation, 171-514 MHz



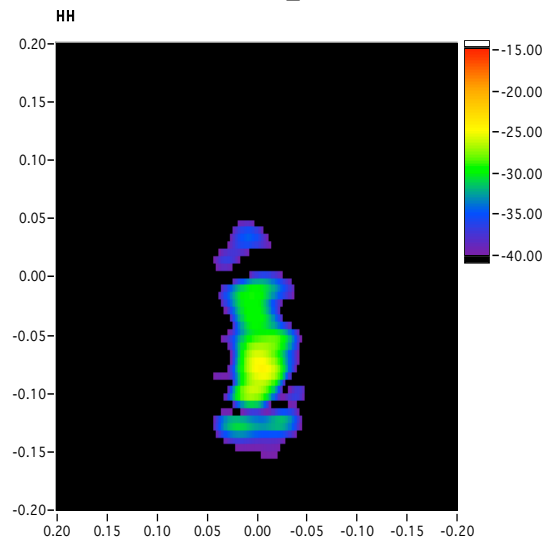


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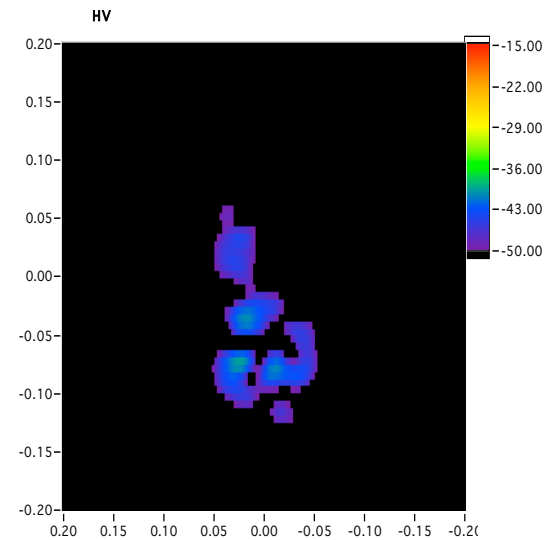
# Imagery of M1 Tank in Open Field

0° aspect, 45 ° elevation, 171-514 MHz

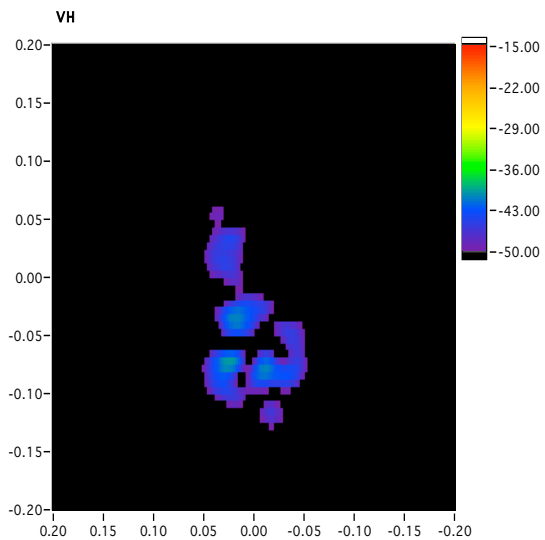
HH



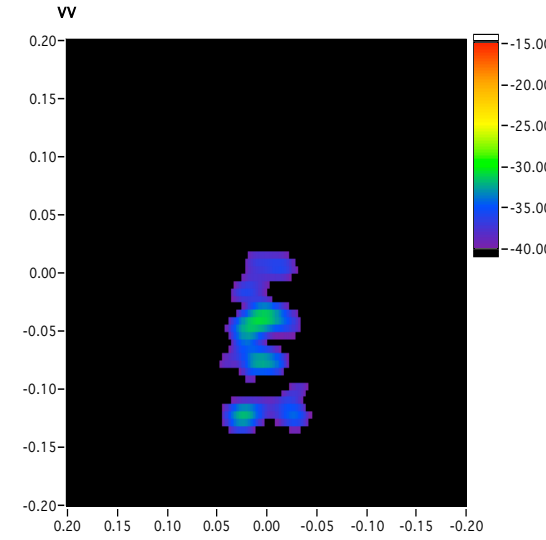
HV



VH



VV



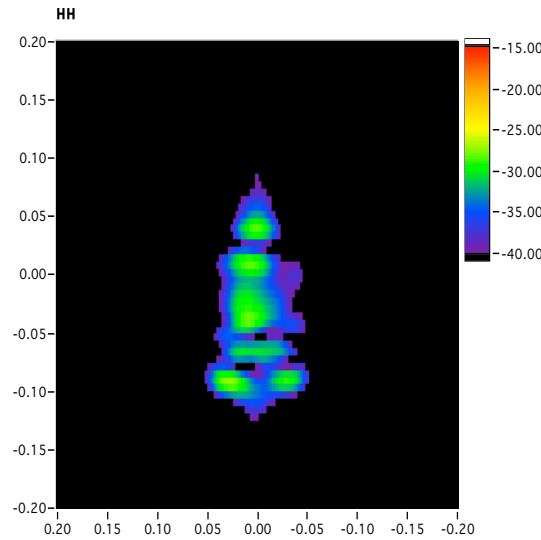


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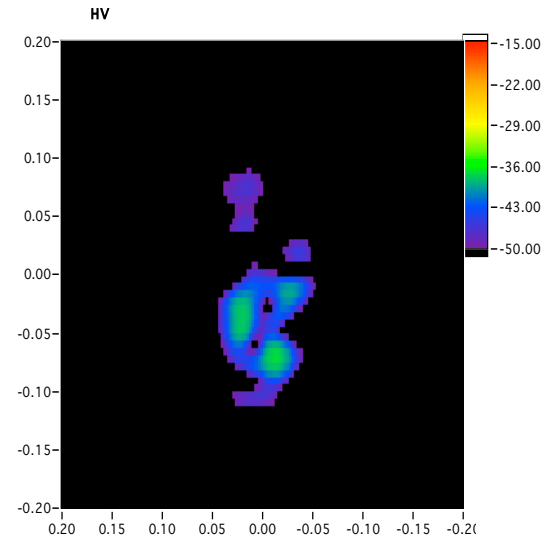
# Imagery of T-72 Tank in Open Field

0° aspect, 45 ° elevation, 171-514 MHz

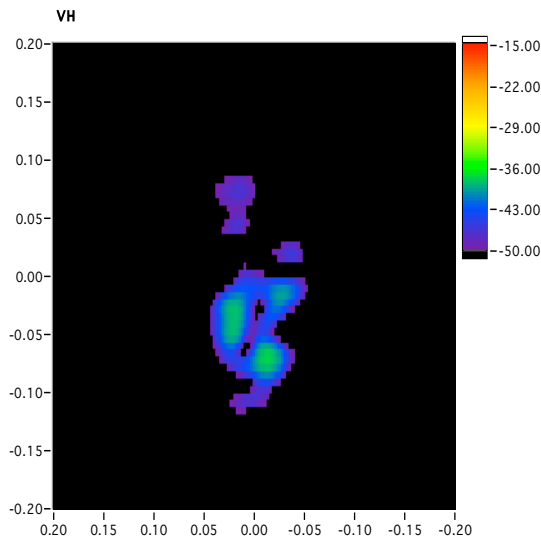
HH



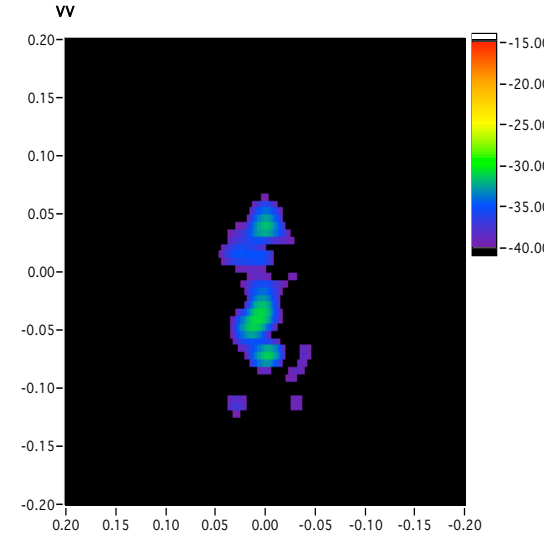
HV



VH



VV



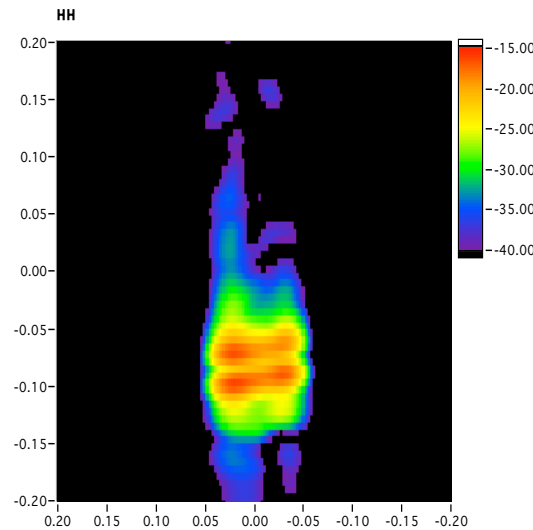


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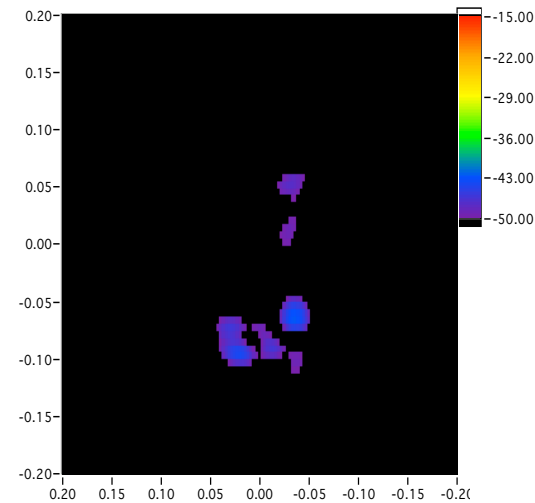
# Imagery of Tank Decoy in Open Field

0° aspect, 45 ° elevation, 171-514 MHz

HH

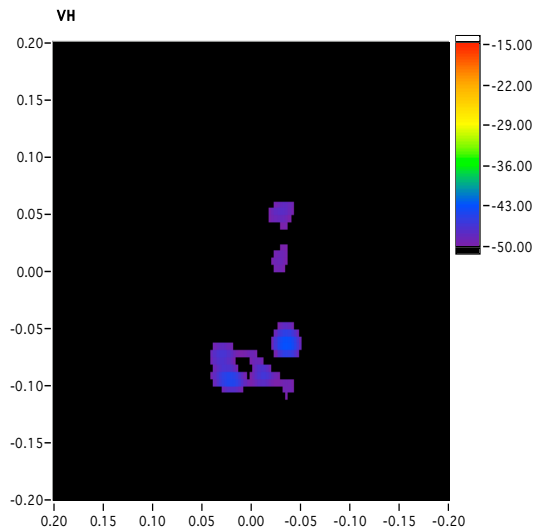


HV

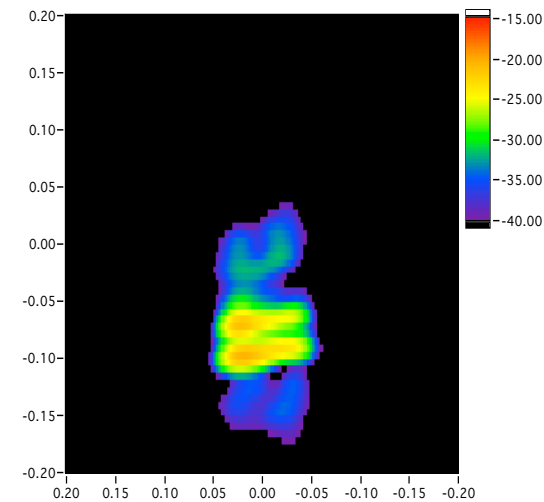


HV

VH



VV



VV



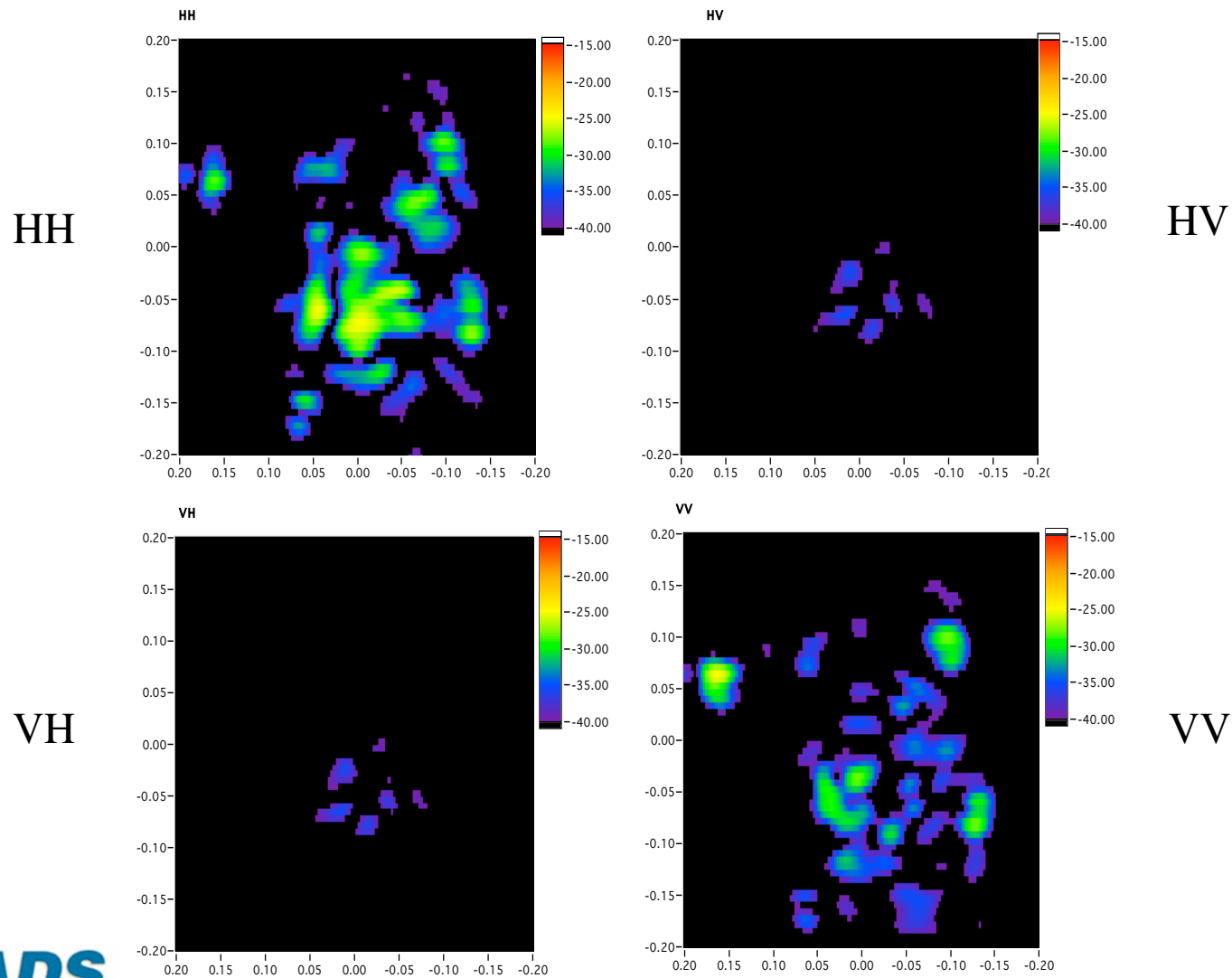




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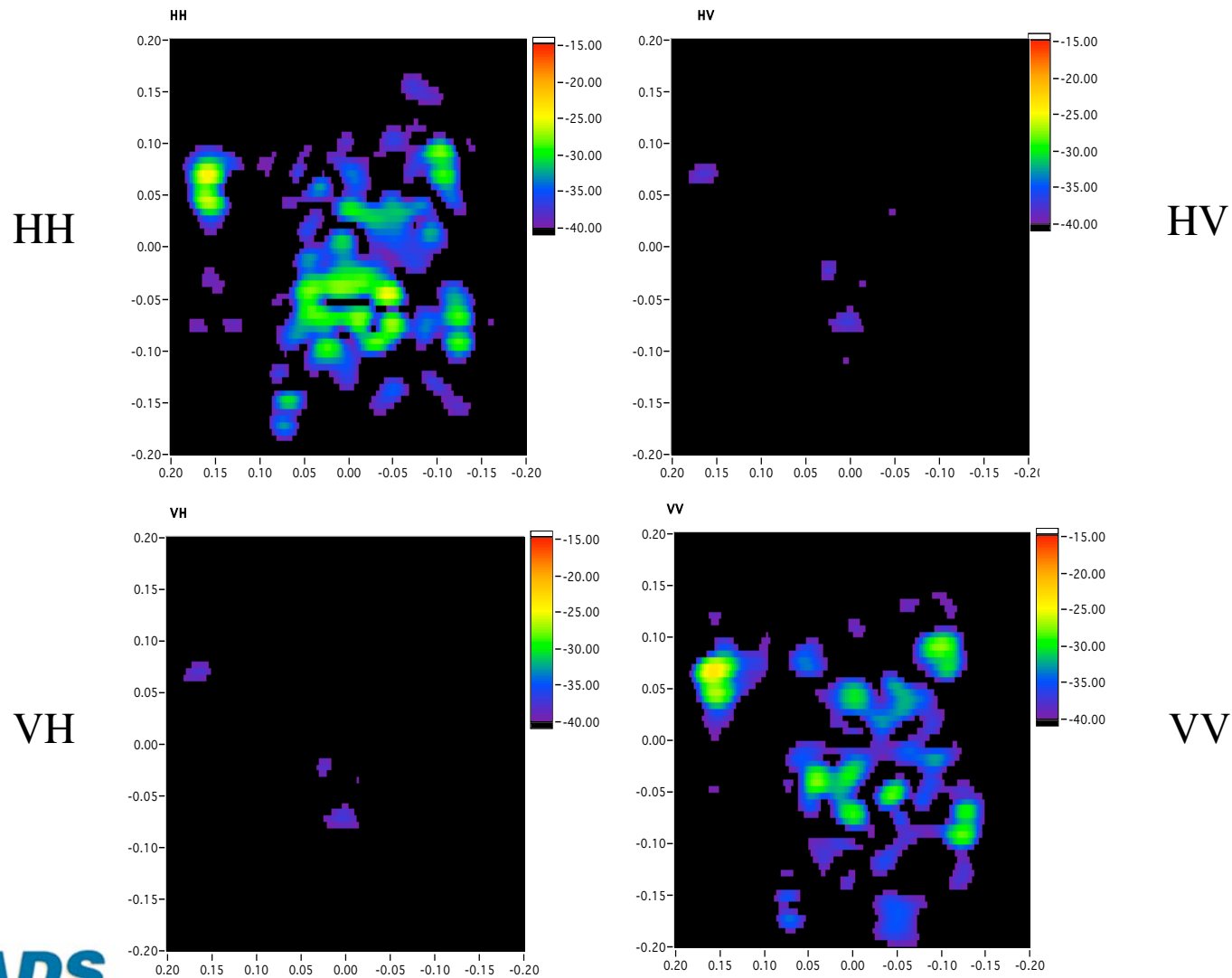
# Imagery of M1 Tank Obscured by Trees

0° aspect, 45 ° elevation, 171-514 MHz



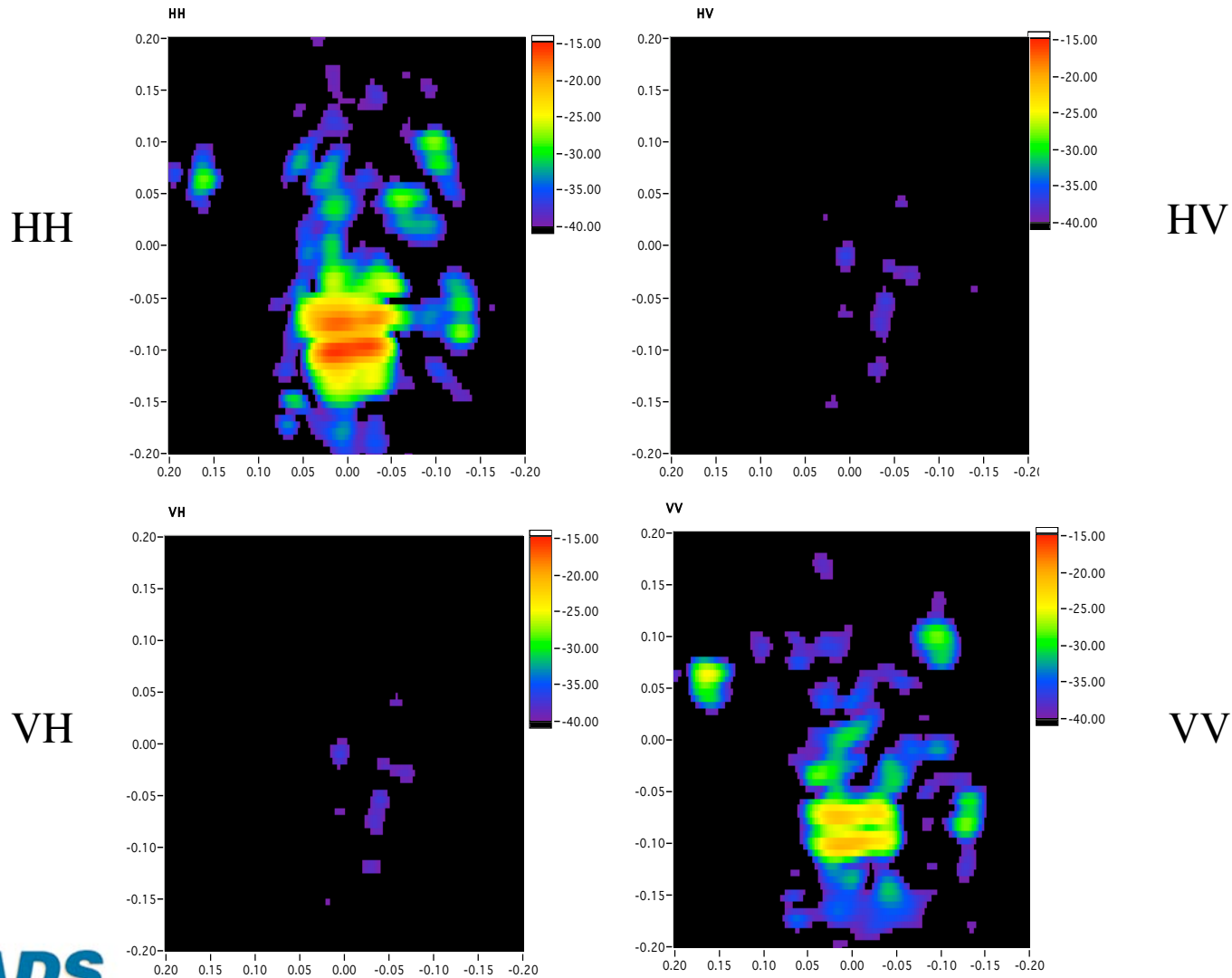
# Imagery of T-72 Tank Obscured by Trees

0° aspect, 45 ° elevation, 171-514 MHz



# Imagery of Tank Decoy Obscured by Trees

0° aspect, 45 ° elevation, 171-514 MHz



# UHF & W-band Imagery of BMP-2

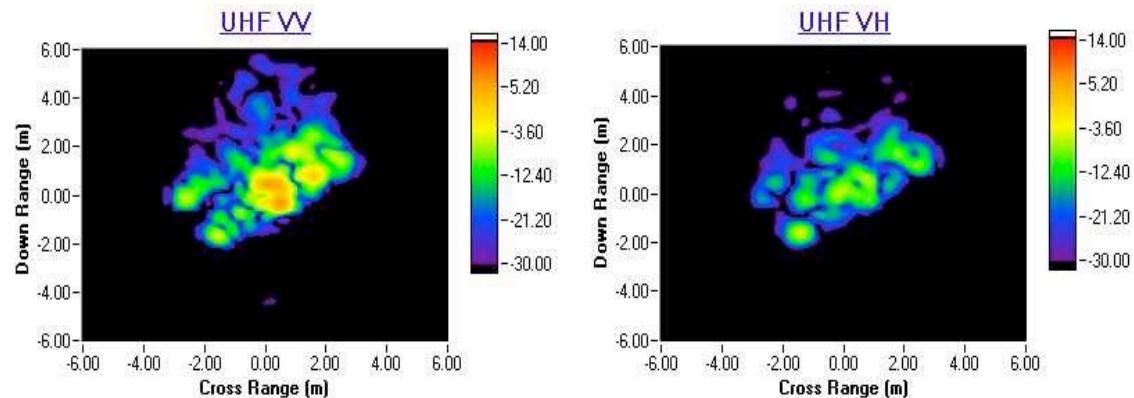
Free-space, 40° elevation, Image center angle 55°

UHF and W-Band Bandwidth: 487.5 MHz --> 0.31 (m) down range resolution

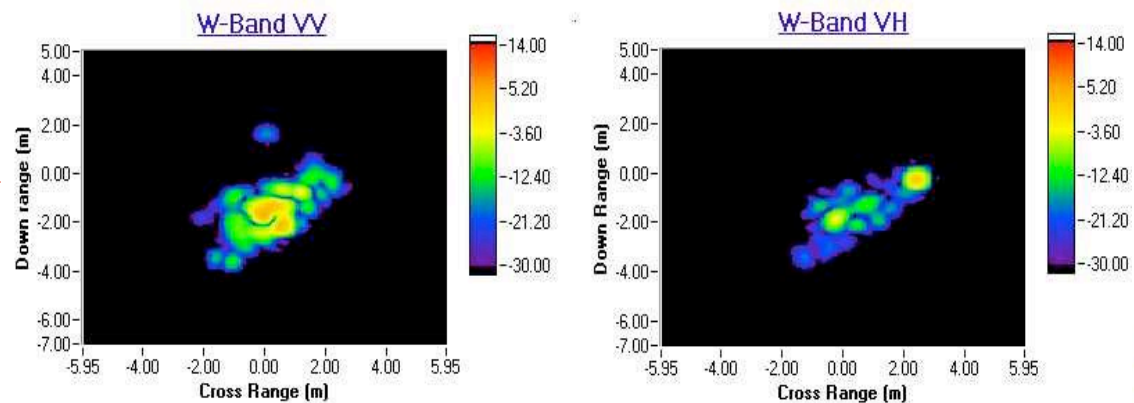
UHF aperture 75 deg --> 0.31 (m) cross range resolution

W-Band aperture 0.288 deg --> 0.31 (m) cross range resolution

**UHF Imagery**



**W-band Imagery**





# Program Accomplishments

- Established Fully-Polarimetric Pulsed-cw 2-18 GHz Radar Range
- Acquired Calibrated VHF/UHF Signatures of Scale Models in Forested Terrain
- Demonstrated Signature Validation with MoM Code (CARLOS)
- Developed Signal Processing Techniques for FOPEN ISAR Imaging
- Developed Dielectrics to Model Live Wood
- Fabricated Ground Planes Modeling Smooth, Moist Soil Surface